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(54) Dielectric filter, dielectric duplexer and communication apparatus

(57) A dielectric resonator (5) is electrically connected to an input terminal (1) through a coupling capacitor (C1). A dielectric resonator (6) is electrically connected to an output terminal (2) through a coupling capacitor (C3). The dielectric resonators (5, 6) are electrically connected to each other through a coupling capacitor (C2). A voltage control terminal (3) is electrically connected to the cathode of a variable-capacitance diode (D1) and to one end of the coupling capacitor (C1) through a choke coil (L1). The anode of the variable-capacitance diode (D1) is electrically connected to the dielectric resonator (6). That is, the variable-capacitance diode (D1) is used as a multipath circuit element of a filter (15).

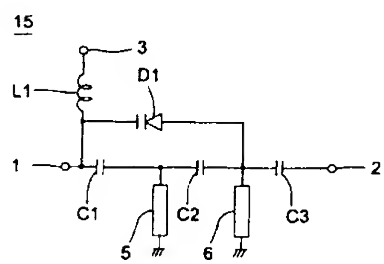


FIG.1

EP 0 881 700 A1

Description

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

The present invention relates to a dielectric filter, a dielectric duplexer and a communication apparatus having the dielectric filter and the dielectric duplexer.

2. Related Art of the Invention

Frequency band variable type dielectric filters such as those using variable-capacitance diodes D11 and D12 shown in Figs. 11 and 12 have been proposed for designing portable telephone sets smaller in power consumption and in size.

Fig. 11 shows the circuit configuration of a conventional variable-frequency bandpass filter. In the circuit shown in Fig. 11, portion 1 is an input terminal; portion 2 is an output terminal; portion 3 is a voltage control terminal; components 5 and 6 are dielectric resonators; components C21, C22, and C23 are coupling capacitors; components C24 and C25 are capacitors for changing a frequency band; components D11 and D12 are variable-capacitance diodes; and components L11 and L12 are choke coils.

Fig. 12 shows the circuit configuration of a conventional variable-frequency bandstop filter. In the circuit shown in Fig. 1, portion 1 is an input terminal; portion 2 is an output terminal; portion 3 is a voltage control terminal; components 5 and 6 are dielectric resonators; components C26 and C27 are capacitors; component L10 is a coupling coil; components C28 and C29 are coupling capacitors for determining an amount of stop band attenuation; components C24 and C25 are capacitors for changing a frequency band; components D11 and D12 are variable-capacitance diodes; and components L11 and L12 are choke coils.

The dielectric filter thus arranged has a center frequency determined by the resonant frequencies of resonant systems respectively formed of the capacitances of the variable-capacitance diodes D11 and D12, the capacitances of the capacitors C24 and C25, and the dielectric resonators 5 and 6. The capacitances of the variable-capacitance diodes D11 and D12 are changed by changing a voltage applied to the voltage control terminal 3, thus enabling variable setting of the center frequency.

The conventional dielectric filters, however, have a drawback in that, since the variable-capacitance diodes D11 and D12 for variable setting of a center frequency are respectively connected to dielectric resonators 5 and 6 in parallel with the same, a deterioration is caused in Q_O of the resonant systems (Q at the center frequency) by addition of the capacitances of the variable-capacitance diodes D11 and D12 in parallel with the dielectric resonators 5 and 6. If it is necessary to largely change the frequency of the dielectric filter, an increase in the capacitances of the variable-capacitance diodes D11 and D12 is required. In such a case, a deterioration in Q_O of the resonant systems cannot be avoided. In particular, because the insertion loss of the bandpass filter is dependent on Q_O of the resonant systems, a deterioration in the electrical characteristic of the dielectric filter in the bandpass filter is considerable.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a dielectric filter and a dielectric duplexer free from any considerable deterioration in Q_O of resonant systems and having a small insertion loss and a large amount of attenuation, and a communication apparatus having the dielectric filter or duplexer.

The present invention provides a dielectric filter comprising: an input terminal, an output terminal, and a voltage control terminal; a plurality of dielectric resonators electrically connected between said input terminal and said output terminal; a variable-capacitance diode electrically connected to at least one of said plurality of dielectric resonators, the capacitance of said variable-capacitance diode being electrically changeable by a control signal from said voltage control terminal; and said variable-capacitance diode being served as a multipath circuit element of a bandpass filter.

The present invention further provides a dielectric filter, comprising: an input terminal, an output terminal, and a voltage control terminal; a plurality of dielectric resonators electrically connected between said input terminal and said output terminal; a PIN diode electrically connected to at least one of said plurality of dielectric resonators, said PIN diode being turned on and off by a control signal from said voltage control terminal; a direct-current cutting capacitor electrically connected in series with said PIN diode on the anode side of the same; said voltage control terminal being electrically connected to a point between said PIN diode and said direct-current cutting capacitor; a series circuit comprising said PIN diode and said direct-current cutting capacitor being served as a multipath circuit element of a bandpass filter.

The present invention further provides a dielectric filter, comprising: an input terminal, an output terminal, and a voltage control terminal; a plurality of dielectric resonators electrically connected between said input terminal and said output terminal; a variable-capacitance diode whose capacitance can be electrically changed by a control signal from said voltage control terminal; a first capacitor electrically connected in series with said variable-capacitance diode on the cathode side of the same; at least one second capacitor electrically connected in parallel with the series circuit of said variable-capacitance diode and said first capacitor; and a parallel circuit comprising said variable-capacitance diode, said first capacitance and said second capaci-

tance is electrically connected in series with at least one of said plurality of dielectric resonators and being served as a trapping capacitor of a bandstop filter.

The present invention further provides a dielectric filter, comprising: an input terminal, an output terminal, and a voltage control terminal; a plurality of dielectric resonators electrically connected between said input terminal and said output terminal; a PIN diode turned on and off by a control signal from said voltage control terminal; at least one capacitor electrically connected in parallel with said PIN diode; and a parallel circuit comprising said PIN diode and said capacitor being electrically connected in series with at least one of said plurality of dielectric resonators and being used as a trapping capacitor of a bandstop filter.

The present invention further provides a dielectric duplexer, comprising at least one of the above described dielectric filters.

The present invention further provides a communication apparatus comprising at least one of the above described dielectric filters and the above described dielectric duplexer.

In the above-described arrangement, an attenuation pole is moved by performing control of a voltage applied to the voltage control terminal such that the capacitance value of the variable-capacitance diode is changed or the PIN diode is turned on and off, whereby a center frequency of the filter is changed. In the dielectric resonator, the capacitance of the device electrically changeable is not connected in parallel with the dielectric resonator, so that a deterioration in Q_O of the resonant system is limited and the insertion loss is reduced while the amount of attenuation is increased.

Also, a dielectric duplexer in accordance with the present invention has at least one of the dielectric filters having the above-described features, thereby limiting a deterioration in Q_O of the resonant system, reducing the insertion loss and increasing the amount of attenuation.

Further, a communication apparatus in accordance with the present invention has at least one of the dielectric filters and the dielectric duplexer having the above-described features and can have improved electrical characteristics using the dielectric filter or dielectric duplexer free from any considerable deterioration in Q_O of the resonant system and having a small insertion loss and a large attenuation amount.

Other features and advantages of the present invention will become apparent from the following description of preferred embodiments of the invention which refers to the accompanying drawings, wherein like reference numerals indicate like elements to avoid duplicative description.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an electric circuit diagram showing the configuration of a first embodiment of a dielectric filter in accordance with the present invention.

Fig. 2 is a cross-sectional view of an example of a dielectric resonator used in the dielectric filter shown in Fig. 1.

Fig. 3 is a graph showing an attenuation characteristic of the dielectric filter shown in Fig. 1.

Fig. 4 is an electric circuit diagram showing the configuration of a second embodiment of the dielectric filter in accordance with the present invention.

Fig. 5 is a graph showing an attenuation characteristic of the dielectric filter shown in Fig. 4.

Fig. 6 is an electric circuit diagram showing the configuration of a third embodiment of the dielectric filter in accordance with the present invention.

Fig. 7 is an electric circuit diagram showing the configuration of a fourth embodiment of the dielectric filter in accordance with the present invention.

Fig. 8 is an electric circuit diagram showing the configuration of a fifth embodiment of the dielectric filter in accordance with the present invention.

Fig. 9 is an electric circuit block diagram showing an embodiment of a dielectric duplexer in accordance with the present invention.

Fig. 10 is an electric circuit block diagram showing an embodiment of a communication apparatus in accordance with the present invention.

Fig. 11 is an electric circuit diagram showing the configuration of a conventional dielectric filter.

Fig. 12 is an electric circuit diagram showing the configuration of another conventional dielectric filter.

PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

[First Preferred Embodiment, Figs. 1 to 3]

Fig. 1 shows the circuit configuration of a variable-frequency bandpass filter 15 having one attenuation pole. A dielectric resonator 5 is electrically connected to an input terminal 1 through a coupling capacitor C1. A dielectric resonator 6 is electrically connected to an output terminal 2 through a coupling capacitor C3. The dielectric resonators 5 and 6 are electrically connected to each other through a coupling capacitor C2.

A voltage control terminal 3 is electrically connected to the cathode of a variable-capacitance diode D1 and to one end of the coupling capacitor C1 through a choke coil L1. The anode of the variable-capacitance diode D1 is electrically connected to the dielectric resonator 6. That is, the variable-capacitance diode D1 forms a multipath circuit which polarizes the filter 15.

For example, as shown in Fig. 2, a coaxial type resonator is used as each of the dielectric resonators 5 and 6. Each of the dielectric resonators 5 and 6 is formed of a cylindrical dielectric member 11 made of a high-dielectric-constant material such as a TiO_2 ceramic, an outer conductor 12 provided on the outer cylindrical surface of the cylindrical dielectric member 11, and an inner conductor 13 provided on the inner cylindrical sur-

face of the cylindrical member 11. The outer conductor 12 has an electrically-open (separated) end apart from the inner conductor 13 at one opening end surface 11a of the dielectric member 11 (hereinafter referred to as open end surface 11a), and is electrically connected to the inner conductor 13 at the other opening end surface 11b (hereinafter referred to as short-circuit end surface 11b). The coupling capacitors C1 to C3 and the anode of the diode D1 are connected to the inner conductors 13 of the dielectric resonators 5 and 6 at the open end surfaces 11a while the outer conductors 12 are grounded at the short-circuit end surfaces 11b.

A center frequency of this variable-frequency bandpass filter 15 is determined by the capacitance of the variable-capacitance diode D1 and resonant frequencies of resonant systems formed by the dielectric resonators 5 and 6. A terminal voltage of the variable-capacitance diode D1 is changed by controlling the value of a direct-current voltage of a variable voltage source (not shown) connected to the voltage control terminal 3. With this change, the capacitance of the variable-capacitance diode D1 is changed. For example, as shown in Fig. 3, attenuation pole 17a of the filter 15 is thereby moved to the point indicated at 17a', with the curve of the attenuation characteristic indicated by the solid line 17 being changed into a curve indicated by the broken line 17', thus changing the center frequency of the filter 15.

Because the variable-capacitance diode D1 is used as a multipath circuit element forming one attenuation pole, and because the variable-capacitance diode D1 is connected to the dielectric resonator 6, the attenuation pole can be changed without parallel connection of the capacitance of the variable-capacitance diode D1 to the dielectric resonator 6. Therefore, a deterioration in Q_O of the resonant systems can be limited and a small insertion loss and a large attenuation amount can be achieved.

[Second Preferred Embodiment, Figs. 4 and 5]

Fig. 4 shows the circuit configuration of variable-frequency bandpass filter 25 having two attenuation poles. Between an input terminal 1 and an output terminal 2, dielectric resonators 5, 6, and 7 form a multistage circuit through coupling capacitors C1, C2, C3, and C4. That is, the input terminal 1 and the dielectric resonator 5 are electrically connected to each other through the coupling capacitor C1; the dielectric resonators 5 and 6 are electrically connected to each other through the coupling capacitor C2; the dielectric resonators 6 and 7 are electrically connected to each other through the coupling capacitor C3; and the output terminal 2 and the dielectric resonator 7 are electrically connected to each other through the coupling capacitor C4.

A voltage control terminal 3 is electrically connected to the cathode of the variable-capacitance diode D1 and to one end of the coupling capacitor C1 through a choke coil L1, and is also connected electrically to the cathode of the variable-capacitance diode D2 and to one end of the coupling capacitor C4 through a choke coil L2. The anodes of the variable-capacitance diodes D1 and D2 are electrically connected to the dielectric resonator 6. That is, the variable-capacitance diodes D1 and D2 form a multipath circuit which polarizes the filter 25.

A center frequency of this variable-frequency bandpass filter 25 is determined by the capacitances of the variable-capacitance diodes D1 and D2 and resonant frequencies of resonant systems formed by the dielectric resonators 5 to 7. The capacitances of the variable-capacitance diodes D1 and D2 are changed by changing the value of a voltage applied to the voltage control terminal 3. For example, as shown in Fig. 5, two attenuation poles 27a and 27b of the filter 25 are thereby moved to the points indicated at 27a' and 27b', with the curve of the attenuation characteristic indicated by the solid line 27 being changed into a curve indicated by the broken line 27', thus changing the center frequency of the filter 25. This variable-frequency bandpass filter 25 operates in the same manner and has the same advantage as the above-described first embodiment filter 15.

[Third Preferred Embodiment, Fig. 6]

As shown in Fig. 6, a third embodiment variable-frequency bandpass filter 35 has a multipath circuit in which PIN diodes D5 and D6 are respectively connected electrically in series with capacitors C5 and C6 which polarize the filter 35 (hereinafter referred to as multipath capacitors C5 and C6). Between an input terminal 1 and an output terminal 2, dielectric resonators 5, 6, and 7 form a multistage circuit through coupling capacitors C1, C2, and C3, and a coupling coil L5. That is, the input terminal 1 and the dielectric resonator 5 are electrically connected to each other through the coupling capacitor C1; the dielectric resonators 5 and 6 are electrically connected to each other through the coupling capacitor C2; the dielectric resonators 6 and 7 are electrically connected to each other through the coupling capacitor C3; and the output terminal 2 and the dielectric resonator 7 are electrically connected to each other through the coupling coil L5. Alternatively, the output terminal 2 and the dielectric resonator 7 may be electrically connected through a coupling capacitor. Attenuation poles are formed on the high-frequency side of the passband in the case where the coupling coil L5 is used while attenuation poles are formed on the low-frequency side of the passband in the case where a coupling capacitor is used.

The series circuit of the multipath capacitor C5 and the PIN diode D5 is connected between the input terminal 1 and the open end surface of the dielectric resonator 6. The series circuit of the multipath capacitor C6 and the PIN diode D6 is connected between the output terminal 2 and the open end surface of the dielectric

resonator 6. The multipath capacitors C5 and C6 cut off direct-current components.

A voltage control terminal 3 is electrically connected to the anode of the PIN diode D5 and to one end of the multipath capacitor C5 through a choke coil L1, and is also connected electrically to the anode of the PIN diode D6 and to one end of the multipath capacitor C6 through a choke coil L2. The cathodes of the PIN diodes D5 and D6 are electrically connected to the dielectric resonator 6.

A center frequency of this variable-frequency bandpass filter 35 is determined by the capacitances of the mutipath diodes C5 and C6 and resonant frequencies of resonant systems formed by the dielectric resonators 5 to 7. When a positive voltage is applied as a control voltage to the voltage control terminal 3, the PIN diodes D5 and D6 are turned on. Conduction is thereby caused between the multipath capacitors C5 and C6 and the dielectric resonator 6 via the PIN diodes D5 and D6. Conversely, when a negative voltage is applied as a control voltage, the PIN diodes D5 and D6 are turned off. The multipath capacitors C5 and C6 are thereby isolated from the dielectric resonator 6. Thus, the capacitances of the multipath capacitors C5 and C6 are added to or removed from the dielectric resonator 6 to change multipath circuit constants. That is, the series circuit formed of the PIN diode D5 and the multipath capacitor C5 is used as a multipath circuit element of the filter 35. Also, the series circuit formed of the PIN diode D6 and the multipath capacitor C6 is used as a multipath circuit element of the filter 35. Consequently, attenuation poles of the filter 35 can be moved to change the center frequency.

In the above-described filter 35, the PIN diodes D5 and D6 provided as a multipath circuit element are connected to the dielectric resonator 6, so that a deterioration in resonance system Q_O can be limited and a small insertion loss and a large attenuation amount can be achieved.

[Fourth Preferred Embodiment, Fig. 7]

As a fourth embodiment, an example of a variable-frequency bandstop filter will be described. As shown in Fig. 7, a variable-frequency bandstop filter 45 has a resonating capacitor C15 electrically connected in series to the cathode of a variable-capacitance diode D1, and has a resonating capacitor C17 connected in parallel with this series circuit of the variable-capacitance diode D1 and the resonating capacitor C15. Similarly, a resonating capacitor C16 is electrically connected in series to the cathode of a variable-capacitance diode D2, and a resonating capacitor C18 is connected in parallel with this series circuit of the variable-capacitance diode D2 and the resonating capacitor C16. The parallel circuit formed of the variable-capacitance diode D1, the resonating capacitor C15 and the resonating capacitor C17 is electrically connected in series to a dielectric resonator 5 while the parallel circuit formed of the variable-capacitance diode D2, the resonating capacitor C16 and the resonating capacitor C18 is electrically connected in series to a dielectric resonator 6, thus forming a trap circuit.

Trap frequencies of this variable-frequency bandstop filter 45 are determined by the resonant frequency of the resonant system formed of the capacitance of the variable-capacitance diode D1, the resonating capacitors C15 and C17 and the dielectric resonator 5 and the resonant frequency of the resonant system formed of the capacitance of the variable-capacitance diode D2, the resonating capacitors C16 and C18 and the dielectric resonator 6. The capacitances of the variable-capacitance diodes D1 and D2 are changed by changing the value of a voltage applied to a voltage control terminal 3 to change trap circuit constants. That is, the parallel circuit formed of the resonating capacitors C15 and C17 and the variable-capacitance diode D1 is electrically connected in series with the dielectric resonator 5 to be used as a trapping capacitor of the filter 45. Also, the parallel circuit formed of the resonating capacitors C16 and C18 and the variable-capacitance diode D2 is electrically connected in series with the dielectric resonator 6 to be used as a trapping capacitor of the filter 45. Attenuation poles of the filter 45 are thereby moved to change the trap frequencies.

[Fifth Embodiment, Fig. 8]

As shown in Fig. 8, a fifth embodiment variable-frequency bandstop filter 65 has a trap circuit formed of resonating capacitors C15 and C17, and C16 and C18 connected in parallel, and PIN diodes D5 and D6 electrically connected in series with the capacitors C15 and C16, respectively.

Trap frequencies of this variable-frequency bandstop filter 65 are determined by the resonant frequency of the resonant system formed of the resonating capacitors C15 and C17 and the dielectric resonator 5 and the resonant frequency of the resonant system formed of the resonating capacitors C16 and C18 and the dielectric resonator 6. When a positive voltage is applied as a control voltage to a voltage control terminal 3, the PIN diodes D5 and D6 are turned on. Conduction is thereby caused between the resonating capacitor C15 and the dielectric resonator 5 via the PIN diode D5 and between the resonating capacitor C16 and the dielectric resonator 6 via the PIN diode D6. Conversely, when a negative positive voltage is applied as a control voltage, the PIN diodes D5 and D6 are turned off. The resonating capacitors C15 and C16 are thereby isolated from the dielectric resonators 5 and 6.

The capacitances of the resonating capacitors C15 and C16 are thereby added to or removed from the dielectric resonators 5 and 6 to change trap circuit constants. That is, the parallel circuit formed of the resonating capacitors C15 and C17 and the PIN diode

D5 is electrically connected in series with the dielectric resonator 5 to be used as a trapping capacitor of the filter 65. Also, the parallel circuit formed of the resonating capacitors C16 and C18 and the PIN diode D6 is electrically connected in series with the dielectric resonator 6 to be used as a trapping capacitor of the filter 65. Attenuation poles of the filter 45 are thereby moved to change the trap frequencies.

[Sixth Preferred Embodiment, Fig. 9]

The sixth embodiment is an example of a dielectric duplexer in accordance with the present invention.

As shown in Fig. 9, a dielectric duplexer 73 is formed by combining two variable-frequency bandpass filters 15 described above as the first embodiment. For example, this dielectric duplexer 73 is used to perform bi-directional communication in a motor vehicle telephone system or the like. Different frequency bands are determined as frequency bands used for transmitting and receiving. In Fig. 9, a component 74 is a transmitting section, a component 75 is a receiving section, a component 76 is a control section for changing the center frequency of each filter 15 to a desired frequency by changing a voltage at a terminal of a variable-capacitance diode D1 included in the filter 15, and a component 77 is a transmitting and receiving antenna. Needless to say, while two filters 15 are combined in the sixth embodiment, any two of the variable-frequency bandpass filters 15, 25, and 35 described above as the first to third embodiments may be combined to form a dielectric duplexer.

[Seventh Preferred Embodiment, Fig. 10]

The seventh embodiment is a communication apparatus in accordance with the present invention, which will be described as a portable telephone set by way of example.

Fig. 10 is an electrical circuit block diagram of an RF section of a portable telephone set 120. In Fig. 10, a component 122 is an antenna element, a component 123 is an antenna sharing filter (duplexer) 123, a component 131 is a transmitting-side isolator, a component 132 is a transmitting-side amplifier, a component 133 is a transmitting-side interstage bandpass filter, a component 134 is a transmitting-side mixer, a component 135 is a receiving-side amplifier, a component 136 is a receiving-side interstage bandpass filter, a component 137 is a receiving-side mixer, a component 138 is a voltage control oscillator (VCO), and a component 139 is a local bandpass filter.

For example, the above-described fifth embodiment dielectric duplexer 73 can be used as antenna sharing filter (duplexer) 123. For example, each of the dielectric filters 15, 25, and 35 described above as the first to third preferred embodiments can be used as transmitting-side and receiving-side interstage bandpass filters 133 and 136 and local bandpass filter 139.

The dielectric filter, the dielectric duplexer and the communication apparatus of the present invention are not limited to the above-described embodiments, and can be variously modified within the scope of the invention.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled man in the art that the forgoing and other changes in form and details may be made therein without departing from the spirit of the invention.

Claims

1. A dielectric filter (15; 25) comprising:

   an input terminal (1), an output terminal (2), and a voltage control terminal (3);
   a plurality of dielectric resonators (5, 6; 5, 6, 7) electrically connected between said input terminal (1) and said output terminal (2);
   a variable-capacitance diode (D1; D1, D2) electrically connected to at least one of said plurality of dielectric resonators (5, 6; 5, 6, 7), the capacitance of said variable-capacitance diode (D1; D1, D2) being electrically changeable by a control signal from said voltage control terminal (3); and
   said variable-capacitance diode (D1; D1, D2) being served as a multipath circuit element of a bandpass filter.

2. A dielectric filter (35) comprising:

   an input terminal (1), an output terminal (2), and a voltage control terminal (3);
   a plurality of dielectric resonators (5, 6, 7) electrically connected between said input terminal (1) and said output terminal (2);
   a PIN diode (D5, D6) electrically connected to at least one of said plurality of dielectric resonators (5, 6, 7), said PIN diode (D5, D6) being turned on and off by a control signal from said voltage control terminal (3);
   a direct-current cutting capacitor (C5, C6) electrically connected in series with said PIN diode (D5, D6) on the anode side of the same;
   said voltage control terminal (3) being electrically connected to a point between said PIN diode (D5, D6) and said direct-current cutting capacitor (C5, C6),
   a series circuit comprising said PIN diode (D5, D6) and said direct-current cutting capacitor (C5, C6) being served as a multipath circuit element of a bandpass filter.

3. A dielectric filter (45) comprising:

an input terminal (1), an output terminal (2), and a voltage control terminal (3);

a plurality of dielectric resonators (5, 6) electrically connected between said input terminal (1) and said output terminal (2);

a variable-capacitance diode (D1, D2) whose capacitance can be electrically changed by a control signal from said voltage control terminal (3);

a first capacitor (C15, C16) electrically connected in series with said variable-capacitance diode (D1, D2) on the cathode side of the same;

at least one second capacitor (C17, C18) electrically connected in parallel with the series circuit of said variable-capacitance diode (D1, D2) and said first capacitor (C15, C16); and

a parallel circuit comprising said variable-capacitance diode (D1, D2), said first capacitance (C15, C16) and said second capacitance (C17, C18) is electrically connected in series with at least one of said plurality of dielectric resonators (5, 6) and being served as a trapping capacitor of a bandstop filter.

4. A dielectric filter (65) comprising:

an input terminal (1), an output terminal (2), and a voltage control terminal (3);

a plurality of dielectric resonators (5, 6) electrically connected between said input terminal (1) and said output terminal (2);

a PIN diode (D5, D6) turned on and off by a control signal from said voltage control terminal (3);

at least one capacitor (C17, C18) electrically connected in parallel with said PIN diode (D5, D6); and

a parallel circuit comprising said PIN diode (D5, D6) and said capacitor (C17, C18) being electrically connected in series with at least one of said plurality of dielectric resonators (5, 6) and being used as a trapping capacitor of a bandstop filter.

5. A dielectric duplexer (73) comprising at least one of the dielectric filters (15; 25; 35; 45; 65) according to Claims 1 to 4.

6. A communication apparatus (120) comprising at least one of the dielectric filters (15; 25; 35; 45; 65) according to Claims 1 to 4 and the dielectric duplexer according to Claim 5.

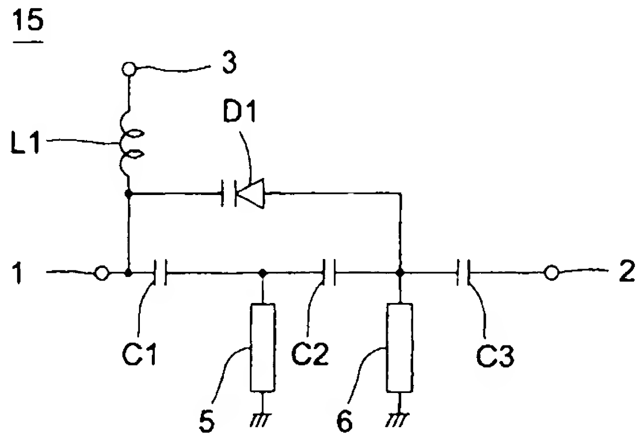


FIG.1

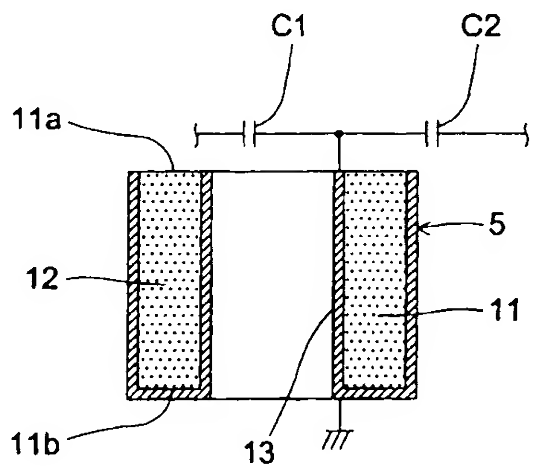


FIG.2

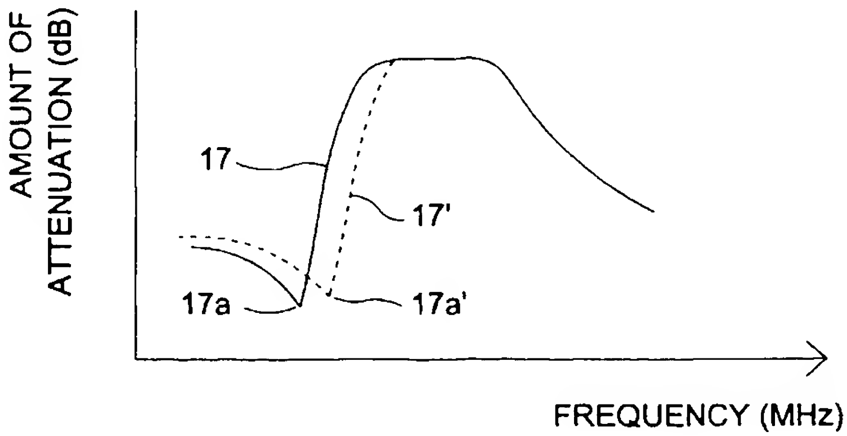


FIG.3

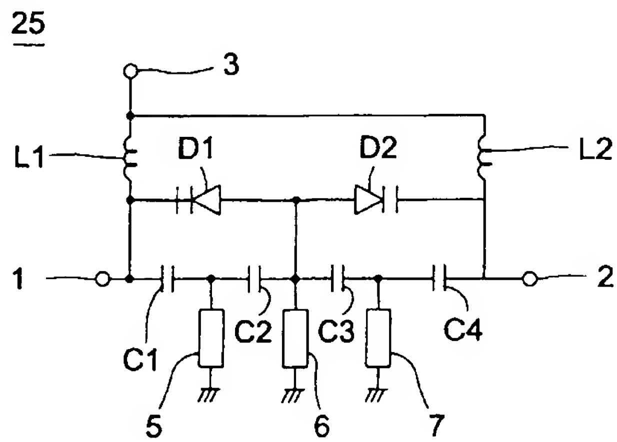


FIG.4

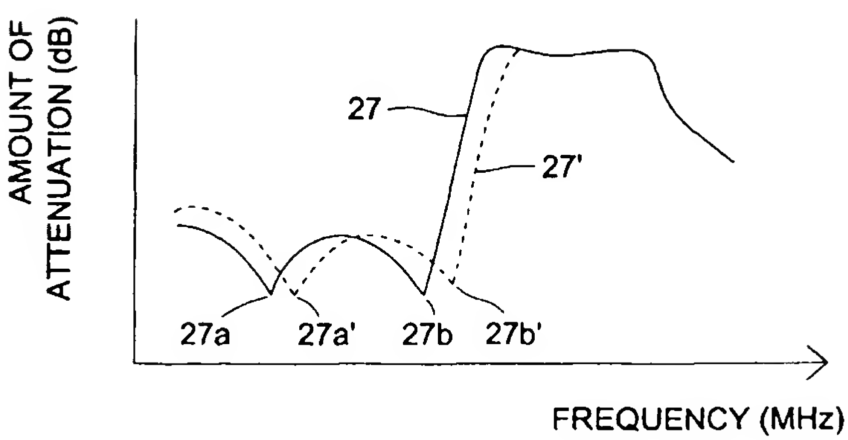


FIG.5

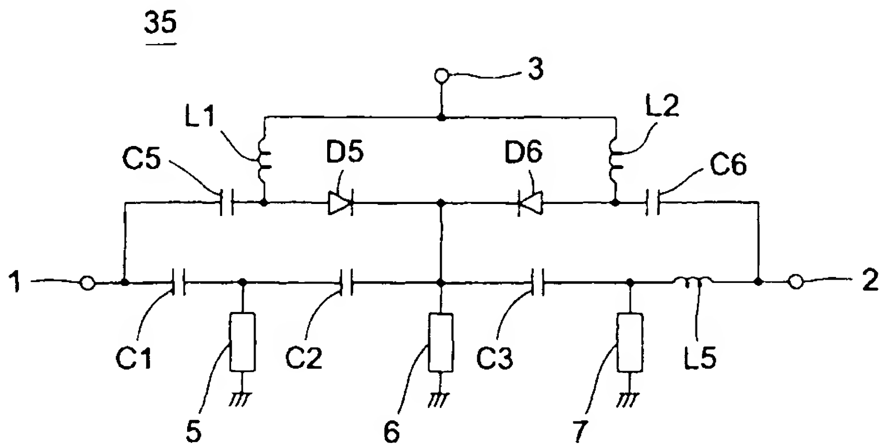
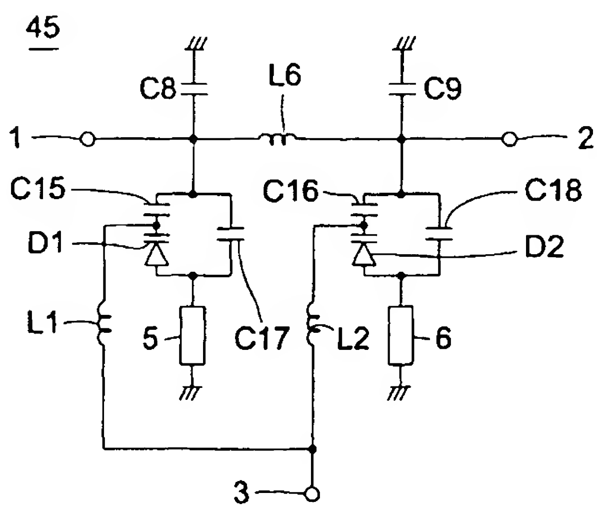

35
3
L1
L2
C5
D5
D6
C6
1
2
C1
C2
C3
L5
5
6
7

FIG.6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L6
C9
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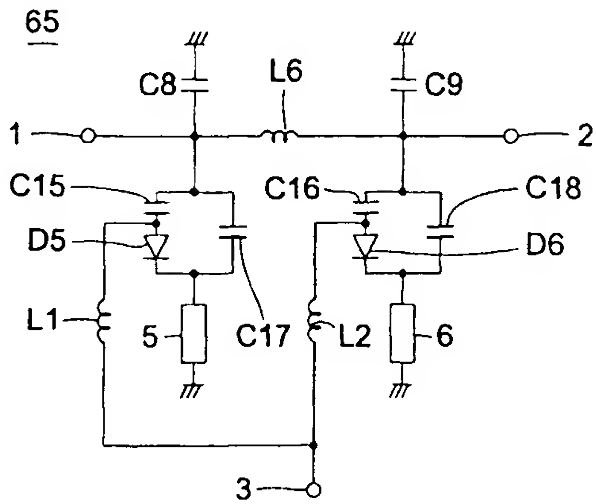
C15
C16
C18
D1
D2
L1
5
C17
L2
6
3

FIG.7


65
C8
L6
C9
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C15
C16
C18
D5
D6
L1
5
C17
L2
6
3

FIG.8

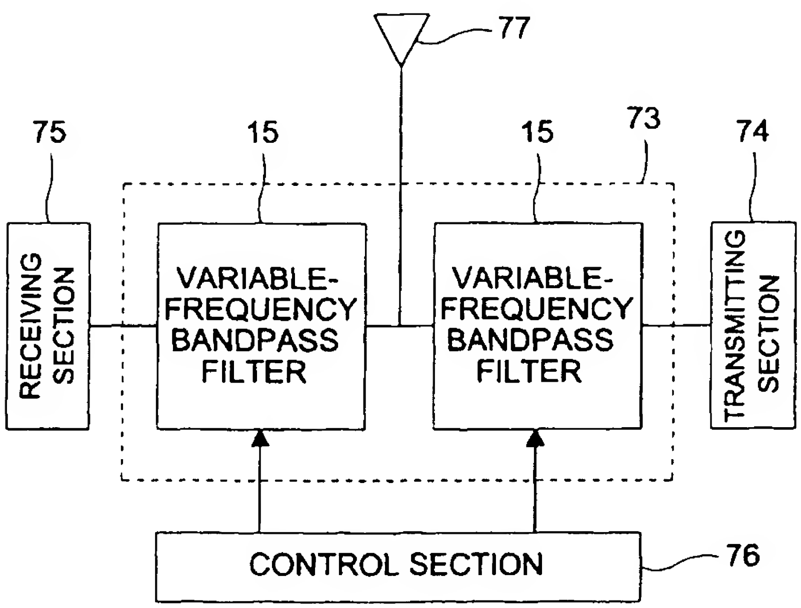
77
75
15
15
73
74
RECEIVING SECTION
VARIABLE-FREQUENCY BANDPASS FILTER
VARIABLE-FREQUENCY BANDPASS FILTER
TRANSMITTING SECTION
CONTROL SECTION
76

FIG.9

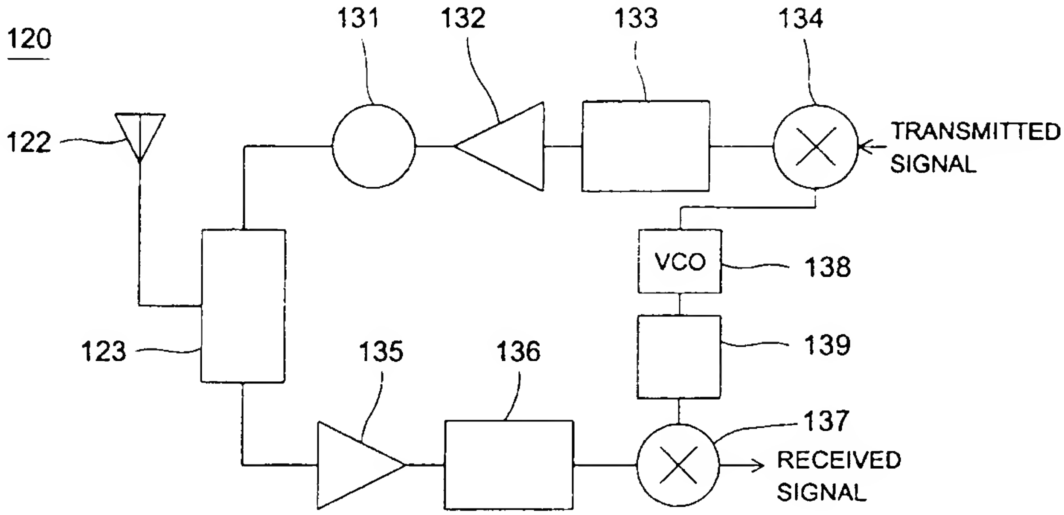
120
131
132
133
134
122
TRANSMITTED
SIGNAL
VCO
138
139
123
135
136
137
RECEIVED
SIGNAL

FIG.10

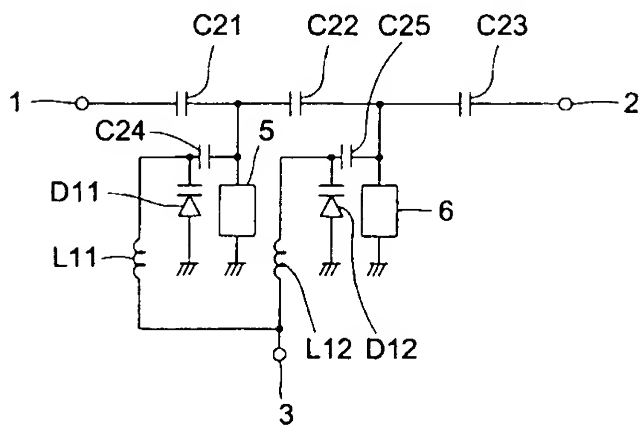
C21
C22
C25
C23
1
2
C24
5
D11
6
L11
L12
D12
3

FIG.11

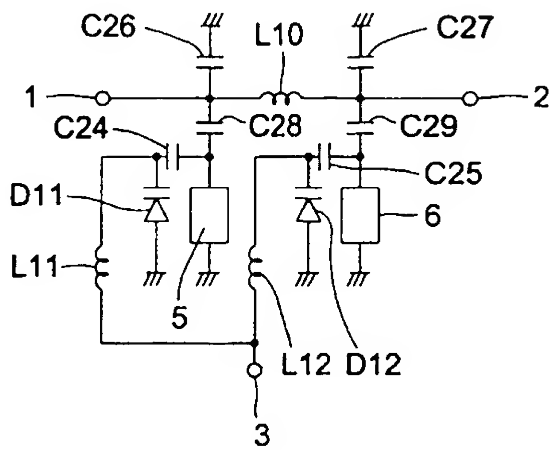

FIG.12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 9775

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 055 808 A (WALKER ET AL.) 8 October 1991 * column 4, line 13 - line 36; figure 5 * ---	1,2,5,6	H01P1/205
X	PATENT ABSTRACTS OF JAPAN vol. 96, no. 11, 29 November 1996 & JP 08 186406 A (MATSUSHITA ELECTRIC IND CO LTD), 16 July 1996 * abstract * ---	1,6	
A	WO 94 27376 A (MOTOROLA INC.) 24 November 1994 * page 10, line 28 - page 13, line 21; figures 2-4 * ---	4	
A	US 5 065 120 A (MUNN) 12 November 1991 * column 3, line 16 - line 37; figure 5 * ---	4	
A	PATENT ABSTRACTS OF JAPAN vol. 96, no. 4, 30 April 1996 & JP 07 321509 A (KOKUSAI ELECTRIC CO LTD), 8 December 1995 * abstract * -----	4	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
H01P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 September 1998	Den Otter, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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